Fig. 4.32 a–d Evaluating the mobility of a suspicious-looking filling defect by correlation between the prone and supine scans.

a The supine endoluminal 3D view shows a sessile polypoid filling defect on a semilunar fold in the sigmoid colon that is suggestive of a sessile polyp. Note the individual morphological characteristics of the colonic segment, such as the diverticula (arrowheads), and the semilunar fold (*) in front of the filling defect.

b, c Coronal or (as here) sagittal views are used to locate the corresponding segment in the prone scan.

d After precise correlation with the same fold (arrow) and the other intraluminal landmarks (arrowheads, *) at the same site in the sigmoid colon, it is ascertained that no polypoid lesion is visible in the prone scan. A polyp can be excluded.

Mucosal Polyps

For colonic polyps, a general distinction is made between adenomatous and nonadenomatous polyps, although it must be noted that these cannot be differentiated at CT colonography.
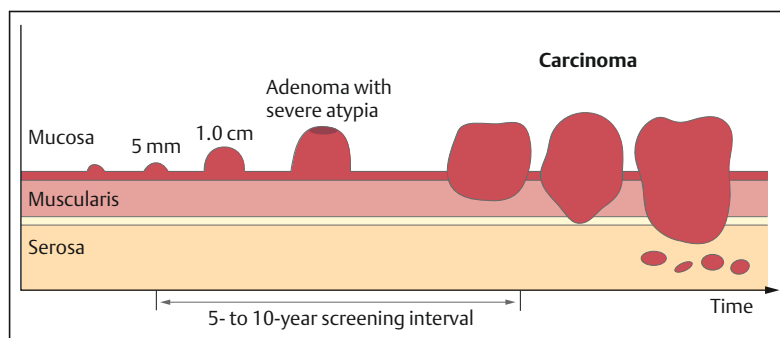
Adenomatous Polyps

Adenoma–carcinoma sequence. Adenomatous polyps represent the most common benign neoplasm affecting the colonic mucosa. However, 80%–90% of all colorectal carcinomas develop from initially small adenomatous polyps via the adenoma–carcinoma sequence (**Fig. 4.33**). Over the course of 10–15 years, several genetic mutations occur that cause small adenomas (<5 mm) to develop into large advanced adenomas (>10 mm) and finally to invasive carcinomas. The risk of malignant transformation increases with the size of the lesion. Invasive carcinoma is found in less than 1% of all adenomas with a diameter smaller than 1 cm, less than 5% of all adenomas with a diameter greater than 1 cm, and in 30%–50% of adenomas with a diameter greater than 2 cm.

> **!** Advanced adenoma is defined by a lesion size of at least 10 mm and/or the presence of a substantial villous component (>25%) and/or the presence of high-grade dysplasia. This benign lesion is considered to be associated with a relatively high risk of progression to cancer. It therefore represents the ideal target lesion for prevention of colorectal cancer.

The detection and correct measurement of adenomatous polyps is thus of central importance in CT colonography, because the size of a lesion has a high prognostic value for the risk of malignancy. Painstaking endoscopic removal of all adenomas can therefore help to reduce the incidence of colorectal carcinoma.

Histology. Based on their histological structure, adenomas may be divided into tubular, villous, and tubulovillous adenomas. Tubular adenomas are the most common, accounting for 80%–85% of colorectal adenomas. They usually have a smooth surface, and are usually smaller than 1 cm. They comprise 30%–40% of all polyps smaller than 5 mm. They are well differentiated and have a lower rate of malignant transformation than the other subtypes. Tubulovillous adenomas make up 10%–15% of all

4

Fig. 4.33 Adenoma–carcinoma sequence. Overall, 80%–90% of all colorectal carcinomas arise from adenomatous polyps, over a period of several years. The risk of malignant transformation increases with polyp size.

colorectal adenomas, are often larger than 1 cm, and undergo malignant transformation more often than tubular adenomas. Pure villous adenomas are rare, accounting for only 5% of colorectal adenomas. They often have a lobulated surface, usually a broad base, and are often larger than 2 cm. These lesions have the highest rate of malignant transformation of all adenoma types. Villous adenomas are grouped together with adenomas with a villous component of more than 25% and invasive carcinomas as advanced neoplasms of the colon. Serrated adenomas also exist; it is assumed that there is a separate pathway of malignant transformation for these lesions which allows smaller lesions to transform into invasive carcinomas more rapidly than through the classic adenoma–carcinoma sequence.

Nonadenomatous Polyps

Nonadenomatous polyps are a mixed group. Histologically, a general distinction is made between hyperplastic polyps, mucosal polyps (elevations of normal epithelium), juvenile polyps, inflammatory polyps, and hamartomas. Hyperplastic polyps are the most common nonadenomatous polypoid lesion, accounting for 75% of nonadenomatous polyps. The majority of hyperplastic polyps are smaller than 6 mm. Lesions larger than 10 mm may, however, often have a flat or atypical morphology, which can make their identification at CT colonography difficult. In general, all nonneoplastic polyps share the common feature that they have no malignant potential. Nonadenomatous polyps comprise the majority (up to about 80%) of polyps smaller than 6 mm and around 40% of all polyps 6 mm in size or larger.

Macroscopic Criteria

Colorectal polyps may be divided by macroscopic morphology into broad-based sessile, flat, and pedunculated polyps. Differentiation on computed tomography between neoplastic and nonneoplastic polyps, or between individual histological subtypes of polyps, is generally impossible for technical reasons. The same CT morphological imaging criteria apply therefore to various histological subtypes of mucosal polyps. At the present state of CT colonography, only classification by the main macroscopic characteristics (sessile–flat–pedunculated) and by size is possible.

However, detection rates have been reported in the recent literature to be higher for adenomatous polyps than for nonadenomatous polyps. This effect might be related to the lower conspicuity of nonadenomatous polyps. Most hyperplastic polyps are small (<6 mm) and they have been reported often to have a flat or elongated shape, to flatten out or even become effaced with air distension of the colon.

The Paris endoscopic classification

The Paris classification (2002) is a classification for endoscopic assessment of superficial neoplastic lesions (Type 0) of the esophagus, stomach and colon. Based on this classification, neoplastic lesions found at optical colonoscopy are divided in polypoid colorectal neoplasms (type 0-I) and nonpolypoid colorectal neoplasms (type 0-II). Polypoid lesions are further divided into sessile (type 0-Is) and pedunculated lesions (type 0-Ip). Intermediate lesions—"subpedunculated" polyps (type 0-Isp)—are mentioned additionally and should be treated as sessile lesions. Nonpolypoid neoplastic lesions—so-called flat lesions—are further divided into slightly elevated (type 0-IIa), completely flat (type 0-IIb), and depressed (type 0-IIc) in relation to the normal adjacent mucosa. Although this endoscopic classification is increasingly referred to in connection with CT colonography, it has not yet been established whether adopting it for CT colonography makes sense.

Current Status of CT Colonography

Study results. Preliminary studies on symptomatic patients have reported promising detection rates for colorectal polyps. It is especially worth noting that some of these studies used single-slice CT scanners (**Table 4.2**). An early meta-analysis by Halligan and colleagues (2005) that included 24 studies published between 1999 and 2003 showed a sensitivity of more than 90% for the detection of patients with polyps measuring 10 mm or more. Despite much initial enthusiasm, however, some of the subsequent large prospective studies with more modern technical equipment have only partially confirmed these results.

In 2003, a prospective landmark study by Pickhardt and colleagues reported that CT colonography had a 93.8% sensitivity for patients with adenomatous polyps 10 mm in size or larger in an asymptomatic study population. How-

Table 4.2 Single-slice CT colonography: study results for polyp detection (sensitivity)

| Polyp size		≤5 mm		6–9 mm		≥10 mm	
Authors, year	Number of patients	Polyps, %	Patients, %	Polyps, %	Patients, %	Polyps, %	Patients, %
Hara et al. 1997	70	25–27[a]	45[a]	56–69[b]	66[b]	67–73	75
Dachman et al. 1998	44	0–15	–	33[c]	–	83[d]	–
Fenlon et al. 1999	100	55	–	82	94	91	96
Fletcher et al. 2000	180	–	–	47	88[b]	75	85
Yee et al. 2001	300	59[a]	82[a]	80	93	90	100
McFarland et al. 2002	70	–	–	36	71	68	88
Pineau et al. 2003	205	–	–	75	84[e]	78	90

[a] < 5 mm
[b] ≥ 5 mm
[c] 5–8 mm
[d] ≥ 8 mm
[e] ≥ 6 mm

Table 4.3 Multidetector CT colonography: study results for polyp detection (sensitivity)

Polyp size		≤5 mm		6–9 mm[a]		≥10 mm	
Authors, year	Number of patients	Polyps, %	Patients, %	Polyps, %	Patients, %	Polyps, %	Patients, %
Macari et al. 2002	105	12	–	70	–	93	–
Iannaccone et al. 2003	158	51	–	83	–	100	–
Pickhardt et al. 2003	1233	–	–	86[a]	89[a]	92	94
Macari et al. 2004	68	12	–	53	–	100	100
Cotton et al. 2004	600	8	14	23	30	52	55
Van Gelder et al. 2004	249	33–37	–	64–75	76–80	75–77	84[a]
Rockey et al. 2005	614	–	–	47	51	53	59
Johnson et al. 2007	452	–	–	55[b]	71[b]	95[b]	95[b]
Johnson et al. 2008[c]	2531	–	–	70[a]	78[a]	84	90
Graser et al. 2009[d]	307	59.2	–	90.2	91.3[a]	93.9	92
Regge et al. 2009[e]	937	–	–	58.6		84.1	

[a] Marked studies used the size category "≥6 mm."
[b] With double reading
[c] ACRIN 6664 Trial
[d] Munich Cancer Prevention Trial
[e] IMPACT Trial

ever, in subsequent studies, other authors such as Cotton and colleagues (2004) and Rockey and colleagues (2005) reported sensitivities between 34% and 53% for lesions of the same size. These mixed results are largely due to methodological differences between the studies, and may be explained by differences in examination technique, in data analysis, and in the expertise of the individual examiners in CT colonography. Large prospective single- and multicenter studies have recently reported high sensitivity rates. The results of large prospective studies (ACRIN 6664 Trial, Munich Screening Trial, IMPACT Trial) demonstrate that, when well performed, i.e., with an adequate examination technique and with the necessary expertise on the part of the radiologist, CT colonography sensitivity rates of 90% and over can be achieved for detection of clinically significant polyps 10 mm in size or larger in asymptomatic patients (**Table 4.3**). With regard to detection of the clinically more relevant advanced neoplasia, Kim et al. (2007) and Stoop et al. (2012) reported in two studies that CT colonography is virtually equal to conventional colonoscopy. Most recently, further prospective trials such as the Madeira Teleradiology Study (Belgium, Madeira–Portugal) and the SIGGAR Trial (United Kingdom) have been completed, with preliminary results indicating that CT colonography performs as well as colonoscopy in the detection of relevant colorectal adenomas or colorectal cancer.

4
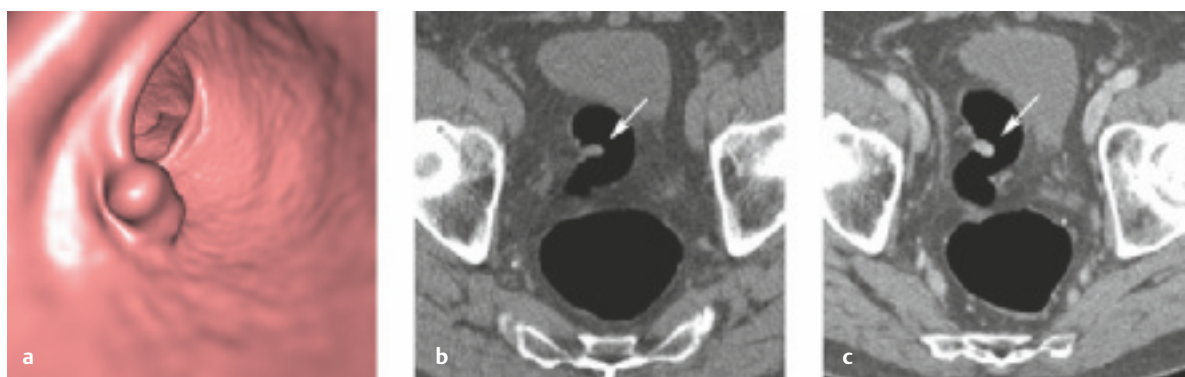
Fig. 4.34 a–c   Sessile, ovoid polyp on a semilunar fold.

**a** Endoluminal 3D view showing an ovoid polypoid lesion. Two-dimensional views are necessary to distinguish more.

b An unenhanced axial 2D image in the prone position demonstrates a homogeneously soft-tissue-attenuation polypoid lesion at the rectosigmoid junction (arrow).

c The corresponding supine contrast-enhanced 2D image shows that the lesion has remained in position and has taken up the intravenous contrast, which is an indication that it is a polyp (arrow).
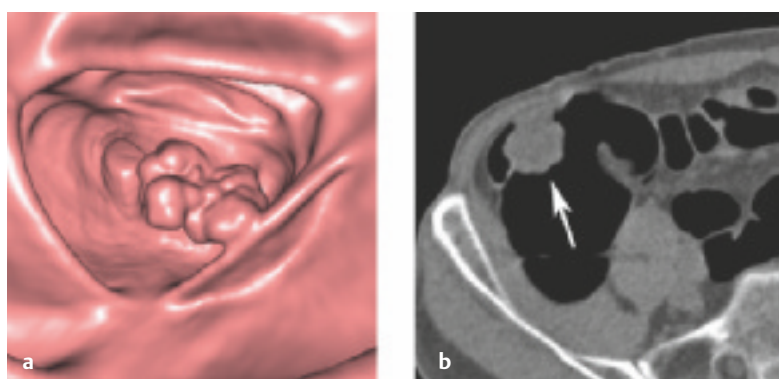
Fig. 4.35 a, b   Sessile, 2.4-cm lobulated polyp in the ascending colon.

a The endoluminal 3D view shows a polypoid lesion with a lobulated surface.

b The corresponding axial 2D image shows a lesion with soft-tissue attenuation (arrow). Histological analysis revealed it to be a villous adenoma.
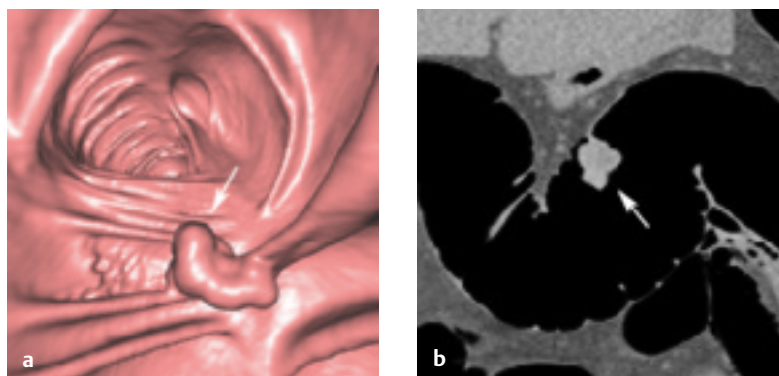
Fig. 4.36 a, b   A 2.1-cm lobulated polyp in the transverse colon located on a semilunar fold.

a The endoluminal 3D image shows a polypoid lesion with a nodular surface.

b The coronal 2D image shows a homogeneous internal structure with soft-tissue attenuation.
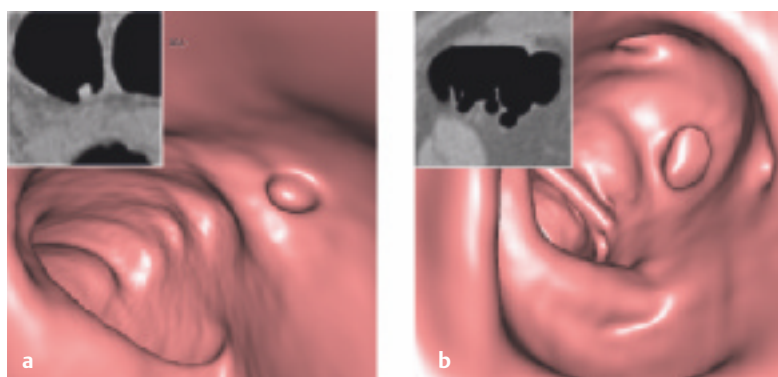
Sessile Polyps

Morphology. On 3D views, sessile polyps appear as hemispherical, usually round or ovoid, or else lobulated intraluminal filling defects (**Fig. 4.34**). Smaller lesions often have a smooth surface. In some instances, sessile polyps may also have a lobulated or nodular surface (**Fig. 4.35**). These polyps are often larger with a slightly irregular appearance, which may be a sign of a villous component (**Fig. 4.36**). Polyps generally tend to be round and, unlike residual fecal matter, do not have sharp edges or borders.

If a polyp is viewed en face on 3D endoluminal views, its margin is typically seen as an incomplete black ring shadow ("incomplete rim sign"), while diverticula viewed en face have a complete black ring ("complete rim sign," see "Diverticula," p. 88) (**Fig. 4.37**).

Internal structure. On 2D views, polyps demonstrate soft-tissue attenuation and have a homogeneous structure. Average CT densities for benign colorectal polyps on unenhanced scans are 50 ± 15 HU. If intravenous contrast is given, polyps increase in CT density by 50–60 HU (see **Fig.**

Fig. 4.37 a, b Distinguishing a sessile polyp from a diverticulum on endoluminal 3D views.

a This endoluminal 3D view shows a sessile polyp with an incomplete ring shadow at the lesion's outer margin. The corresponding 2D image (inset) is diagnostic as it clearly shows the presence of a polypoid lesion.

b An endoluminal 3D view in another patient shows a diverticulum with a complete dark ring at the outer margin of the lesion. The corresponding 2D image (inset) shows an air-filled outpouching in the wall.
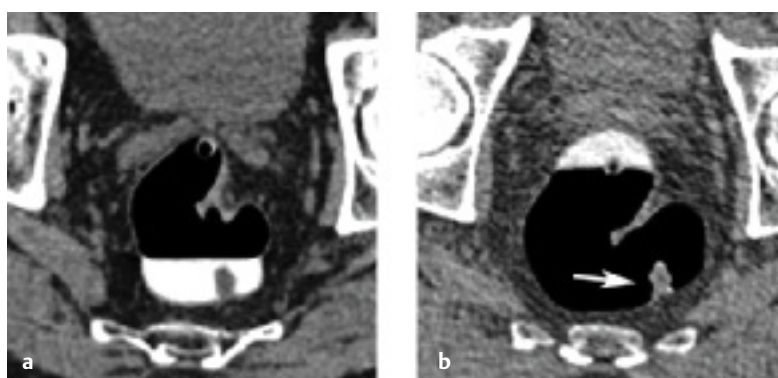
Fig. 4.38 a, b Sessile rectal polyp in an examination with fecal tagging.

a On this axial 2D view in the supine position taken after oral administration of a contrast agent, a submerged sessile polyp is easily distinguished in the tagged fluid as a filling defect with soft-tissue attenuation.

b The corresponding image from the prone scan shows that the hyperdense tagged fluid has moved with gravity, whereas the polyp has remained in place (arrow). Only the polyp surface shows slight coating with the contrast agent.
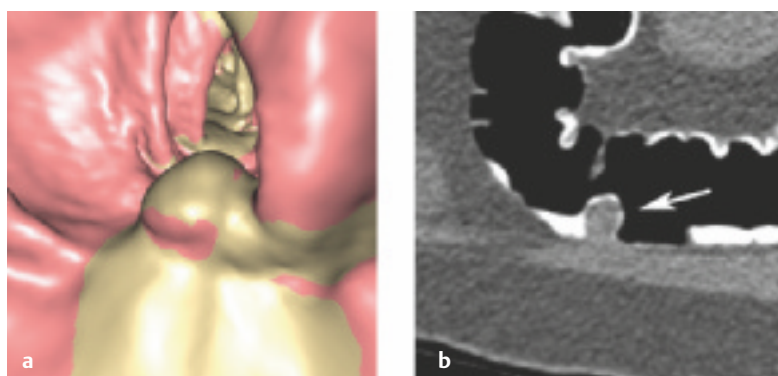

Fig. 4.39 a, b Contrast coating of polyps after fecal tagging.

a On an endoluminal 3D view with electronic labeling, tagged adherent stool on a polyp is color coded.

b The 2D view shows a hyperdense coating of contrast material lying on the soft-tissue-attenuation polyp (arrow).

4

4.34). This contrast enhancement may be helpful for the detection of polyps in untagged residual fluid or for the differentiation of polyps from untagged residual stool. In examinations with fecal tagging, residual stool and fluid will take up orally administered contrast agent while polyps will not, and therefore the polyps will maintain a homogeneous soft-tissue attenuation (**Fig. 4.38**). Polyps may often show an adherent superficial layer of tagging material which should not be misinterpreted as representing tagged residual stool. It has been reported that polyps with villous histology may show a higher rate of such contrast adherence than nonvillous polyps (**Fig. 4.39**).

Mobility. Because sessile polyps arise from the mucosa, they generally do not exhibit any mobility when the patient changes position, whereas remaining fecal material (except for fecal matter that is adherent to the bowel wall) will move across from one bowel wall to the other. Polyps located in mobile bowel segments are a special case that can cause diagnostic confusion. Mobile bowel segments include intraperitoneal bowel segments with a long mesentery such as the sigmoid colon and transverse colon as well as the cecum. In these segments, when the patient moves from prone to supine, the colon may move or shift on its mesocolon. This can result in an apparent change in the position of a polyp between the prone and the supine scans, such as would be typical for residual fecal matter. This phenomenon is referred to as pseudomobility (**Fig. 4.40**).
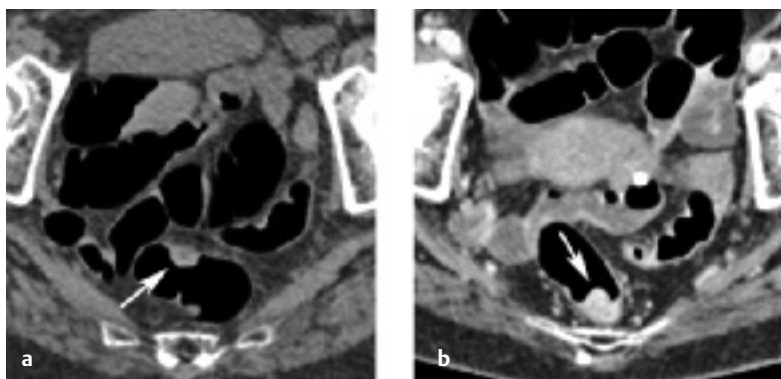
Fig. 4.40 a, b Pseudomobility of a sessile polyp located in a mobile bowel segment.

a The prone scan shows a sessile, soft-tissue-attenuation polyp (arrow) on the anterior bowel wall at the rectosigmoid junction.

b When the patient turns over, the polyp appears to move to the posterior wall of the bowel segment. The enhancement of the lesion suggests that it is a polyp (arrow). Note that the entire colonic segment in which the polyp is located has changed position (Mang et al. 2007).
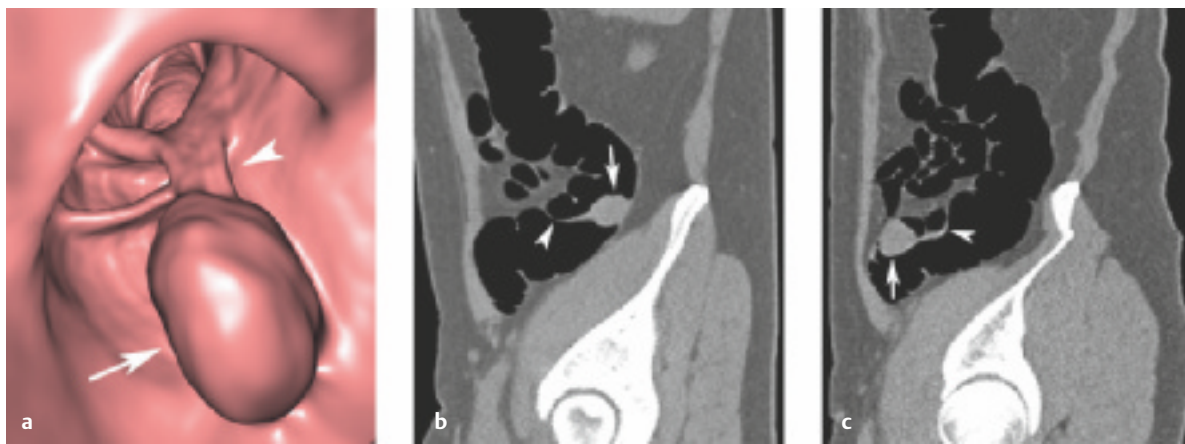
Fig. 4.41 a–c Mobility of a pedunculated polyp in the descending colon when the patient changes position.

a This endoluminal 3D view shows a pedunculated polyp. The polyp head (arrow) is connected to the bowel wall by its stalk.

b A sagittal MPR of the supine scan shows the homogeneously soft-tissue-attenuation polyp head (arrow) on the dorsal wall of the colon.

c When the patient is prone, the polyp head moves on its stalk to the ventral wall of the colon (arrow). *Watch out for:* different positions of the polyp head in the supine and prone positions. (**b**, **c** from Mang et al. 2007.)

Pedunculated Polyps

Morphology and internal structure. A relatively high percentage of the larger polyps are pedunculated. Pedunculated polyps have a round or ovoid head with a smooth or lobulated surface. The polyp head is attached to the bowel wall by a stalk of variable length (**Fig. 4.41**). On 2D views, the assessment criteria for pedunculated polyps are similar to those for sessile lesions. Both the polyp head and the stalk show soft-tissue attenuation with a homogeneous structure and also enhance with intravenous contrast. When fecal tagging is used, stalked polyps do not take up the orally administered contrast medium and thus continue to show homogeneous soft-tissue attenuation (**Fig. 4.42**). To determine the size of a stalked polyp on endoscopy and on CT colonography, only the diameter of the head is measured (see Chapter 3, "Polyp Measurement," p. 62).

Mobility. Mobility—or, rather, pseudomobility—is an important differential diagnostic criterion for pedunculated polyps. Because of the pedunculated morphology, the polyp head on its stalk can move across from the bowel wall on one side to the other in the colonic lumen, and can thus appear to demonstrate mobility (pseudomobility). The longer the stalk, the greater the potential mobility of the polyp head. To distinguish this from mobile residual fecal matter—apart from the already-mentioned structural differences visible on 2D images—identification of the specific polyp morphology may be helpful: for instance, identification of the stalk on 2D views, or of the entire polyp morphology on endoluminal 3D views.

Diagnostic Criteria at CT Colonography

Colon Polyps

3D morphology:
- Sessile or pedunculated, round or ovoid, or else lobulated intraluminal filling defect
- "En face" view: outer margin of filling defect displayed as an incomplete ring shadow
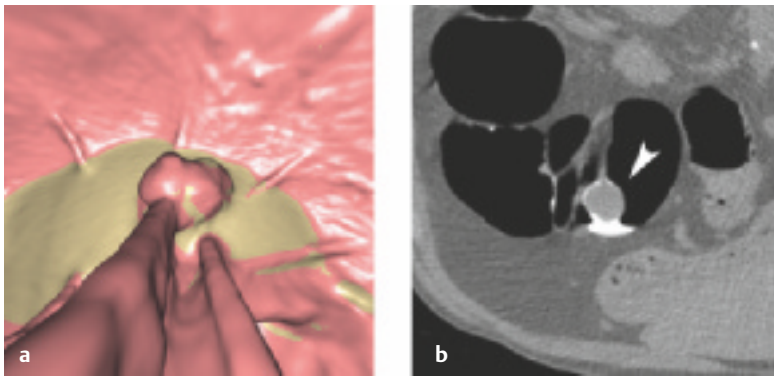
Fig. 4.42 a, b Pedunculated polyp partially submerged in tagged residual fluid.
a This endoluminal 3D image with tagged fecal matter, labeled electronically, shows a polyp partly submerged in residual fluid that has been color coded green.
b The corresponding axial 2D view shows the soft-tissue-attenuation polyp (arrowhead) partly surrounded by hyperdense tagged residual fecal matter.

Fig. 4.43 a–c Flat adenoma in the transverse colon with intravenous contrast.
a The endoluminal 3D image shows a flat-elevated lesion on a semilunar fold (arrow).
b The corresponding unenhanced axial 2D image of the prone scan shows a slight, plaque-like thickening of the wall (arrow) with homogeneous soft-tissue attenuation.

c In the supine scan, the lesion, which has not moved, enhances moderately (arrow) after intravenous administration of contrast medium, suggesting it is a polyp. Histological analysis showed a villous adenoma.

2D structure:
- Circumscribed roundish thickening of the colonic wall with homogeneous soft-tissue attenuation (approx: 30 HU)
- CT does not allow histological differentiation between polyp subtypes

Mobility:
- Sessile polyps do not exhibit mobility
- *Watch out for:* Polyps in mobile colonic segments (transverse colon, sigmoid colon, cecum), which may exhibit pseudomobility
- Pedunculated polyps exhibit pseudomobility

Intravenous contrast:
- Enhancement (to 80—90 HU) (differential diagnosis: residual stool does not enhance)

Fecal tagging:
- No uptake of orally administered contrast agent
- Helpful for differentiation of polyps from tagged bowel content
- Oral contrast may adhere to the surface of polyps, especially those with villous histology

Flat Lesions

Definitions. Flat or nonpolypoid lesions of the colon are characterized by their low elevation in comparison with their width (**Fig. 4.43**). The precise definition of a flat lesion varies and is still under discussion at the present time:
- *Histologically* an adenoma is considered flat if the height of the lesion is less than twice that of the adjacent normal mucosa.
- In *endoscopy,* a commonly used definition for a flat lesion is an elevation of the mucosa with a flat appearance and a height that is less than half the maximum diameter of the lesion (**Fig. 4.44**). This definition may generally be too forgiving, however, since, for example, a lesion measuring 1.1 cm wide and 0.5 cm tall still has a rather polypoid appearance and therefore some polypoid lesions might be classified as flat.
- A more recent and increasingly accepted definition of a flat lesion on *CT colonography* is one where a lesion of 6 mm or greater diameter is elevated no more than 3 mm above the surrounding mucosa.
- Large flat lesions measuring at least 1 cm or more (typically a few centimeters in diameter) are often called "carpet lesions" or "laterally spreading tumors."

4
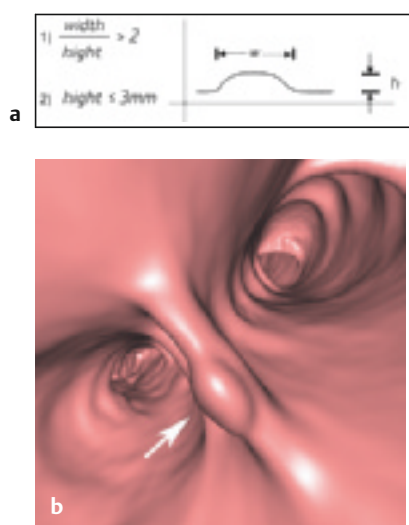
Fig. 4.44 a, b   Various definitions of a "flat" lesion.
a A commonly used definition (1) is that a flat lesion is one whose height is less than half its maximum diameter.
b On the basis of that definition, this oval polyp (arrow) would be incorrectly reported as flat (its height being less than half its maximum diameter). By the recommended CT colonography definition (2 in **a**), however, it is not a flat lesion, as its height exceeds 3 mm.

Categorization

According to the 2002 Paris endoscopic classification (2003), flat neoplastic lesions are categorized as slightly elevated (type 0-IIa), completely flat (type 0-IIb), or depressed (type o-IIc) in relation to the level of the adjacent normal mucosa. Further subcategories—so-called "mixed lesions"—are defined by slight elevation with central depression (type 0-IIa+IIc) and depression with a slightly elevated margin (type 0-IIc+IIa).

Prevalence and malignant potential. The majority (up to 75%) of nonpolypoid colonic lesions have been reported to be nonneoplastic, most of which are hyperplastic (Pickhardt et al. 2010).

The prevalence of flat neoplasms in particular varies widely within the literature. Previously it was held that flat neoplastic lesions rarely occur in Western populations, but it is now known that their frequency is higher than

originally believed, varying from 7% to 40% of all colorectal neoplasms. The malignant potential of flat adenomas compared with that of polypoid lesions is a matter of debate. While some authors report a higher potential for malignant transformation, recent data from the National Polyp Study from the United States do not show a greater risk of malignant transformation for flat lesions. Unlike in polypoid lesions, where the diameter is the reliable predictive criterion for the risk of malignancy, in nonpolypoid "flat" neoplastic lesions the morphologic subtype is of greater importance. Malignancy is more frequent in depressed flat lesions, whereas elevated and completely flat nonpolypoid neoplasms are believed to have the same risk of malignancy as polypoid lesions (2002 Paris endoscopic classification). The vast majority of flat neoplastic lesions however, have a slightly elevated morphology, while completely flat or depressed lesions are extremely rare.

Detectability. Detection rates for flat neoplastic lesions in CT colonography vary in the literature and have been reported to be generally lower than for polypoid lesions. Depending on the study they lie between 50% and 80% (Park et al. 2006; Pickhardt et al. 2004). Because of their morphology, flat lesions are generally less conspicuous and therefore more difficult to detect on CT colonography than sessile polyps. In principle, CT colonography can only detect a lesion if it is elevated above the level of the mucosa. Flat lesions with a height of more than 1–2 mm can therefore be well detected at CT colonography, but a lesion that is not raised at all above the level of the mucosa, or only by less than 1 mm, may hardly be depicted with current spatial resolution (**Fig. 4.45**).

Morphology. In terms of CT morphology, flat lesions are seen as a circumscribed plaque-like thickening of the bowel wall with or without a central depression. As the image quality of 3D reconstructions improves, flat lesions are often easier to identify on 3D than on 2D views. Three-dimensional views show a circumscribed flat elevation of the bowel wall, usually with a smooth surface. Occasionally, the lesion may have a slightly nodular surface (**Fig. 4.46**). Flat lesions with a central depression may present with a slightly elevated peripheral rim. If a flat lesion is located on a semilunar fold, there is usually a circumscribed smooth or nodular thickening or swelling
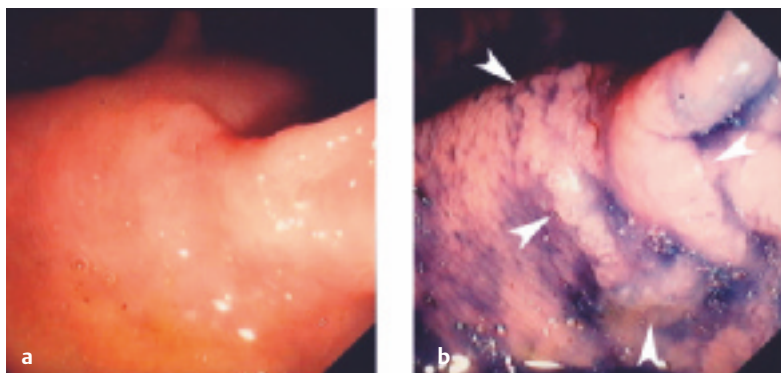
**Fig. 4.45 a, b   Optical colonoscopic appearance of a flat tubular adenoma.**
a Optical colonoscopy shows a barely visible flat, minimally elevated lesion.
b After indigo carmine staining, it is much easier to appreciate the extent of the lesion (arrowheads). Histological analysis revealed a tubular adenoma with high-grade dysplasia. Detecting such flat lesions is challenging whether with CT colonography or with optical colonoscopy.
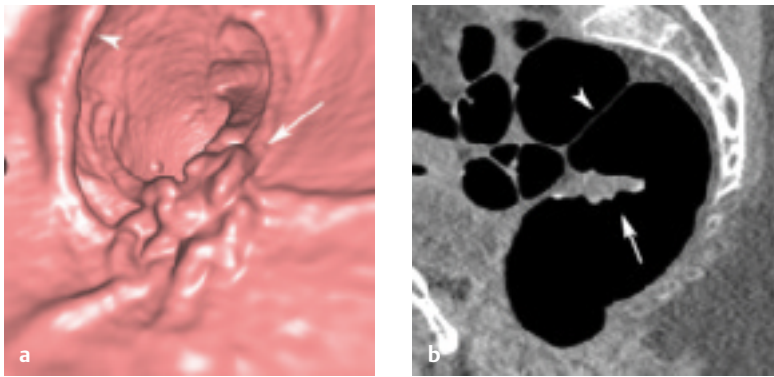
Fig. 4.46 a, b Large flat villous adenoma on Kohlrausch fold in the rectum.

a The endoluminal 3D view shows a flat, irregular thickening of the wall approx. 3 cm in diameter with a nodular surface (arrow). The arrowhead marks a normal-width fold for reference (see **b**).

b The 2D sagittal view shows the soft-tissue attenuation of the lesion (arrow). Note that the fold with the adenoma (arrow) is thicker than the normal-width fold (arrowhead).
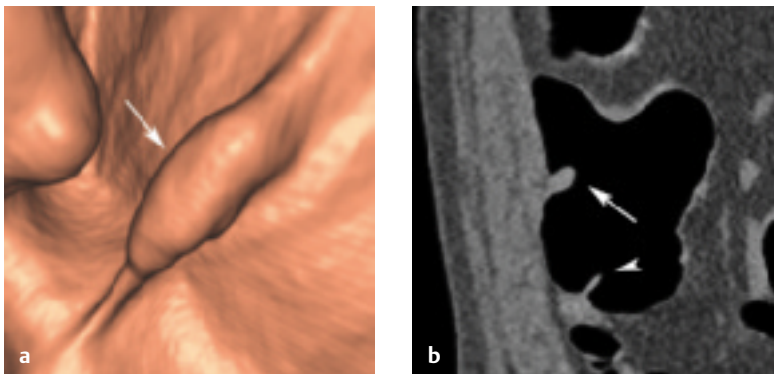
Fig. 4.47 a, b Flat adenoma on a semilunar fold in the cecum.

a The endoluminal 3D view shows a cigar-shaped thickening of the fold (arrow).

b The 2D coronal view shows pathological thickening of the soft-tissue-attenuation fold (arrow) compared with a fold of normal width (arrowhead).
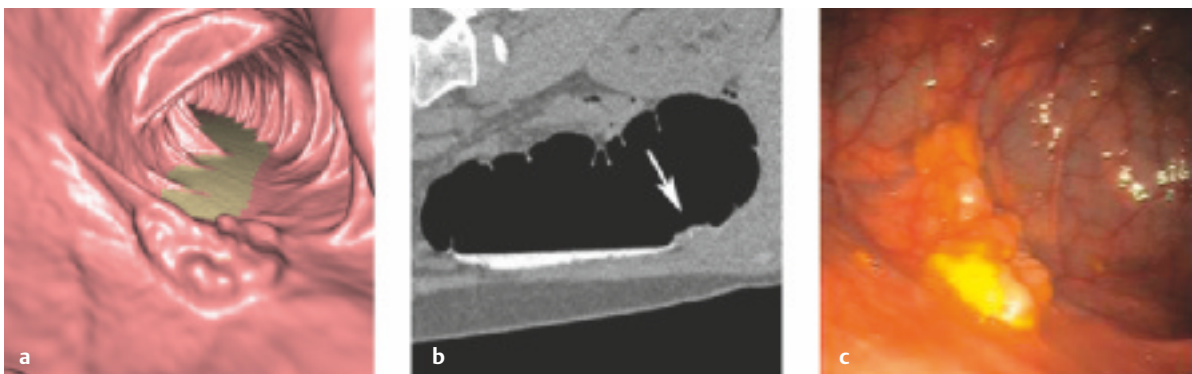
Fig. 4.48 a–c Flat villous adenoma in the transverse colon after fecal tagging.

a The endoluminal 3D view shows a flat lesion with a nodular surface on a semilunar fold (arrow). The tagged residual fluid has been electronically labeled.

b The corresponding 2D view of the prone scan shows the plaque-shaped, soft-tissue-attenuation thickening of the colonic wall, with a coating of tagging material on its surface (arrow).

c Optical colonoscopy with biopsy confirmed the presence of a villous adenoma.

of the semilunar fold that may be especially well seen on 3D endoluminal images. The thickening of the fold may be spindle- or cigar-shaped and it is therefore often described as having a "cigar-shaped" appearance (**Fig. 4.47**).

Inner structure and mobility. On 2D views, flat lesions show a circumscribed low-grade thickening of the wall with homogeneous soft-tissue attenuation. If a flat lesion is located on a semilunar fold, there is noticeable thickening with soft-tissue attenuation. For further morphologi-

cal differentiation, a comparison with adjacent semilunar folds of normal width can be useful (**Figs. 4.46** and **4.47**). Flat lesions are easier to recognize on narrow window settings (soft-tissue windows) than on wide window settings. If an intravenous contrast agent is administered, flat lesions demonstrate enhancement, which can be helpful in distinguishing them from pseudolesions. If fecal tagging is used, residual stool will take up the orally administered contrast material while flat lesions of course will not, and will thus continue to exhibit homogeneous soft-

tissue attenuation (**Fig. 4.48**). Tagged residues may also adhere to the surface of the lesion, resulting in a thin superficial layer of tagging material. Beam-hardening artifacts can reduce the detection of very flat lesions that are surrounded by enhancing intestinal content. Flat lesions are sessile and do not exhibit any mobility when the patient changes position from supine to prone.

> **!** If a flat lesion is detected at CT colonography, additional optical colonoscopy and possibly endoscopic removal with histological work-up are indicated and should be recommended in the radiologist's report.

Diagnostic Criteria at CT Colonography

Flat Lesions

3D morphology:
- Flat, plaque-shaped elevation on the bowel wall with or without a central depression, with a smooth or nodular surface
- Circumscribed spindle-shaped thickening of a semilunar fold ("cigar-shape" appearance)

2D structure:
- Circumscribed low-grade plaque-shaped thickening of the wall with a maximum height of 3 mm and with homogeneous soft-tissue attenuation, better differentiated on soft-tissue windows than on lung window settings

Mobility:
- Flat lesions are sessile and do not exhibit mobility

Intravenous contrast:
- Contrast enhancement can aid differential diagnosis

Fecal tagging:
- No uptake of oral contrast
- Helpful for differentiating flat lesions from residual stool
- Tagging material may adhere to the surface of flat lesions

How to Manage "Diminutive" Polyps

Polyps measuring less than 6 mm continue to be a subject of controversy in CT colonography. In general, with modern scanners, optimum acquisition parameters, and dedicated imaging software, it is technically possible to depict small polypoid filling defects in two and three dimensions (**Fig. 4.49**). However, this assumes that the polyp is more spherical than flat and also that there is optimal bowel preparation without any solid fecal residue (**Fig. 4.50**). Given the small polyp size, computed tomographic differentiation from a pseudolesion on the basis of the previously described 2D morphological criteria is limited, however (**Fig. 4.51**), and diminutive polyps may often be indistinguishable from residual untagged stool, droplets of untagged fluid or mucus, or small submucosal vascular loops causing slight elevations in the mucosa. In particular, small particles of untagged residual stool can adhere to the bowel wall and therefore will not show typical mobility. Because of their small size, it can be impossible to differentiate between residual tiny particles of stool and a diminutive polyp based on 2D morphologic criteria, since tiny particles of stool may not demonstrate typical inhomogeneity like larger amounts of fecal residue. This reduces the specificity of CT colonography for diminutive polyps.

Consistently recommending colonoscopic examination for these diminutive lesions would result in a large number of unnecessary colonoscopies being carried out on the basis of false-positive findings. In addition, the majority of small polyps measuring less than 6 mm have a nonadenomatous histology and hence no potential for malignant transformation. Even for adenomas, the probability of malignant transformation at this small size is extremely low and probably a very gradual process (<1% are histologically advanced). Endoscopic removal of such small lesions is not only costly, but also is associated with a risk of serious complications such as hemorrhage or perforation. Thus, the usefulness of endoscopic follow-up of small polyps is questionable.

For these reasons, both the European Society of Gastrointestinal and Abdominal Radiology (ESGAR) and the
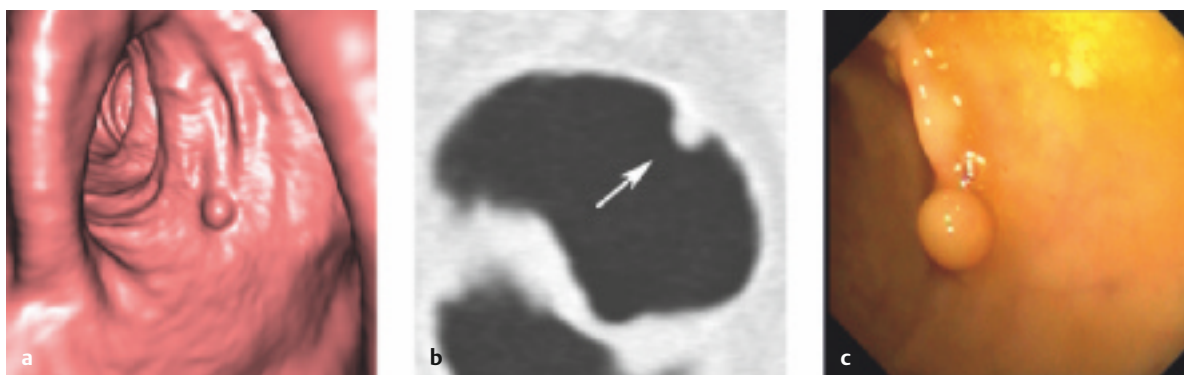
Fig. 4.49a–c   Diminutive 5-mm sessile polyp in the sigmoid colon.
a The polyp is readily identifiable on the endoluminal 3D view.
b The axial 2D view shows homogeneous soft-tissue attenuation of the polyp (arrow).
c Optical colonoscopy confirms the finding.